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PACIFIC NORTHWEST WATERCRAFT POLLUTION STUDY

Pacific Northwest Water Laboratory
Corvallis, Oregon

February 1967

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by the

Technical Services Program

of the

Pacific Northwest Water Laboratory
Corvallis, Oregon

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Northwest Region
Federal Water Pollution Control Administration
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FOREWORD

The purpose of this study was to determine the extent, seriousness, and causes of water pollution in the Pacific Northwest attributable to watercraft users; Further, to determine what legislation and physical means are presently available to control this pollution; and what additional means and legislation are needed.

Due to the limited time available, no technical studies were carried out in conjunction with this evaluation. All data were obtained from existing manuals, reports, and files; and by correspondence and personal interviews with personnel of various Federal, State, local governmental, and private agencies. The contacts are far too numerous to list, but among the major contributors were the U. S. Army Corps of Engineers Division, Portland, and Engineer districts at Juneau, Walla Walla, Portland, and Seattle; the 13th Naval and 13th Coast Guard Districts; the 17th Naval District; the U. S. National Forest Service Regional Offices in Juneau, Portland, and Ogden; U. S. National Park Service Regional Offices in Omaha and San Francisco; and the State Health Departments, Water Pollution Control Boards, Boat Licensing Agencies, and Recreation and Park Service Agencies in the various states.

Without the assistance and cooperation of these, and many others, the collection of these data in the time available would have been impossible.

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SUMMARY OF FINDINGS AND CONCLUSIONS

Due to the great area of water available, and the relatively small population, watercraft pressure in this region is probably less than that in many other areas. However, additional pressure is exerted by the tourists. This pressure, plus the increasing commercial traffic, will increase problems in this area.

Sewage

1. Watercraft are not major contributors of sewage as compared to other sources such as municipalities and industry.

2. Sewage pollution is probably significant under crowded boat conditions such as marinas, docks, moorages, and regattas, and near large ships. However, this has not been documented.

3. Ten to fifteen percent of the recreational boats have toilets and other sanitary facilities, and most of these discharge untreated waste directly to the waters.

4. Most houseboats, Federally-owned ships, and large commercial watercraft, including dredges and canneries, have toilets and other sanitary facilities and discharge untreated waste directly to the waters.

5. The design of sewage collection systems for ships is a major problem, due to the requirements for maintaining water tight compartments. This is not a problem aboard small watercraft.

6. There are presently three methods being used for handling sewage aboard small watercraft, none of which are completely satisfactory. Incinerator use is confined primarily to fecal waste, macerator-chlorinator use can give questionable results, and holding tank use is limited due to an almost complete lack of supporting shore facilities.

7. The design of holding tanks or treatment facilities for ships should not be too difficult, as existing systems can probably be modified to suit the need. Considerable work has already been done along these lines.

8. Foreign vessels constitute a significant percentage of total commercial shipping, and must meet the same standards as U.S. registry vessels if the problem is to be resolved.

9. Port shore facilities such as piers, docks, and servicing areas contribute significant quantities of sewage, as many in this region are not connected to sewer systems, and discharge raw waste to the waters.

10. State laws and regulations vary from state to state; and, Federal regulations vary from those of the states, and also are at variance with each other. This leads to mass confusion in the boating industry and among boaters. There is a great need for sound technical and legal leadership in order to unravel a mass of confusion.

Trash, Debris, and Garbage

11. The amount of this material discharged from watercraft is difficult to assess as it is also contributed by the shoreside population, and a large amount of it sinks to the bottom, including bottles and cans. Personnel in many agencies "feel" it is a significant amount, but cannot quantify significance.

12. The primary cause of this problem is careless, non-thinking people, as it is physically and technically easily resolved. Once the mechanics of a suitable program are established, education and indoctrination are the biggest problems.

13. Means for resolution of this problem are presently quite variable. Personnel on some small craft do throw their trash overboard but many carry bags or other containers and discard or empty them at the marina or moorage, while still others take them home. Some ships and large boats discard indiscrimately; but many discard when at sea, and store while entering port, discharging to shore facilities. The greatest physical need in this area is for provision of more adequate shoreside facilities for the collection and disposal of this material.

14. The Alaskan canneries may present a special problem as they discard large quantities of untreated "garbage," in the form of cannery wastes.

15. State and Federal laws and regulations are generally not too divergent. Many State and Federal agencies specifically prohibit discharge of trash and garbage to waters, whereas others have no specific prohibition against it. Discharge to waters should be prohibited except that these materials could be discharged at sea, and possibly far from shore in certain large inland waters.

Oil and Bilge Waters

16. The disposal of these materials does constitute a serious problem. In spite of legislation and fairly adequate enforcement, unauthorized dumping still occurs; and, when it does, the recreational, aesthetic, and economic results are significant.

17. Most ships attempt to discharge these materials while at sea, but this is not always feasible. Since shore facilities for collection and disposal of these wastes are practically non-existent, the ship's master may have no recourse but to discharge to the harbor or the river. Accidents also cause a certain amount of the problem and there is some intentional pumping, which could be avoided if properly coordinated.

18. The largest problem area is the lack of shore facilities where oil and oil containing wastes can be readily collected and eliminated without causing additional water or air pollution. If these were provided, this problem could become minimal and be confined primarily to accidental discharge.

19. To permit use of shore collection systems a central collection system or systems must also be provided aboard the ships.

20. Legislation appears to be adequate, but it would be desirable that there be some requirement for the provision of supporting shore-based facilities.

Miscellaneous

21. A number of agencies are disturbed about outboard motor exhausts which may deposit significant quantities of gaoline, oil, lead, and other additives to the water.

RECOMMENDATIONS

Sewage

1. Prepare a model law to present to the states. This model law should include the following provisions:

   a. Prohibit the discharge of improperly treated sewage and other liquid waste to any waters under State or Federal jurisdiction.

   b. Require that these wastes be retained in holding tanks for disposal ashore in accordance with laws or rules of the appropriate governmental body; or, the wastes must receive treatment such as to meet specific standards prior to discharge to the waters.

2. Prepare a recommended Federal law, similar to the model law, which will apply to coastal waters, navigable inland waters and tributaries, and other waters under Federal jurisdiction.

3. Increase cooperation with other governmental agencies, and ship owners and design organizations to expedite integration of liquid waste collection and treatment into large boat and ship design.

4. Provide sound guidance to port authorities, private and public marina operators, and other responsible groups on suitable shore-based collection and disposal systems for servicing watercraft.

5. Give increased consideration to proposals for grants and contracts for studies in the area of watercraft liquid waste collection and disposal.

Trash, Debris, and Garbage

6. Prepare a model law, or appropriate section, for presentation to the states. This model law should include the following provisions:

   a. Prohibit the discharge of any garbage, trash, or debris directly to any waters under State or Federal jurisdiction.

b. Require that these wastes be discharged on the high seas; retained in appropriate containers for disposal ashore in accordance with laws or rules of the appropriate governmental body; macerated and treated in the same manner as liquid waste; or incinerated in such a manner as to cause neither water nor air pollution.

7. Prepare a recommended Federal law similar to the model law which will apply to coastal waters, navigable inland waters and tributaries, and other waters under Federal jurisdiction.

8. In cooperation with the United States Public Health Service, provide guidance to port authorities, private and public marina operators, and other responsible groups on suitable shore-based collection systems.

Oil and Bilge Waters

9. Provide guidance to port authorities and other responsible groups on suitable shore-based collection systems for servicing watercraft.

10. In cooperation with the United States Public Health Service provide guidance to these same groups on shore-based disposal systems which will cause neither water nor air pollution.

11. Give increased consideration to proposals for grants and contracts for studies in the area of oil collectors or separators for use aboard ships.

REGIONAL CHARACTERISTICS

For purposes of this report, the Pacific Northwest includes Alaska, Idaho, the portion of Montana contained in the Columbia River Basin, Oregon, and Washington. This includes an area of approximately 856,000 square miles, or slightly less than one-third of the area of the United States,[1] but it only includes a population of 5,612,000, which is less than one-thirtieth of the population of the United States.[2] The four conterminous states are bordered on the north by Canada, and on the west by the Pacific Ocean, whereas Alaska is bounded on the south by the Pacific Ocean, the west by the Bering Sea, the north by the Arctic Ocean, and the east by Canada.

The terrain of the conterminous states varies from sea level to 14,410 feet at Mt. Rainier and from desert to lush areas receiving as much as 146 inches of rainfall.[3] Idaho and Montana do not contain a large number of lakes but the Oregon and Washington area has approximately 20,000 lakes and impoundments between them. In considering major water features one thinks of the Pacific Ocean, Puget Sound, the Columbia and Snake rivers, Crater Lake, Klamath Lake, Coeur d'Alene, Lake Pend Oreille, and Flathead Lake. These and many others have open water year round. Alaska also has great variations. Elevations range from sea level to 20,320-foot Mt, McKinley, and from desert-like conditions to lush lowlands. It is covered with many lakes and rivers, many of which are

frozen a major part of the year. The major water features are the three seas and oceans, the Inland Passage, and the Yukon-Koyukuk-Tanana River System.

In the five states of the Pacific Northwest Region there are 32,000 miles of coastal shoreline, approximately 30,000 lakes and reservoirs, and a total river and stream length of approximately 200,000 miles.

EXTENT OF PROBLEM

Type and Extent of Waterways

Data pertaining to numbers of waterways and waters and mileage or square mileage involved were obtained from many references, none of which present the data in a similar manner. Therefore, a correlation between states was not feasible.

Oregon is reported as having over 46,700 miles of streams, 1,360 major lakes and reservoirs, and over 350 miles of ocean front.(4) Of the 350 mile shoreline, 257 miles are commercially navigable.(5) In addition, there are 774 commercially navigable miles in 61 coastal rivers, and 116 miles in the 49 coves, bays, harbors, and sloughs, for a total of 1,147 miles of navigable waterways.(4,5) The two major navigable coastal rivers* are the Columbia and the Willamette. There are 525 major lakes in Oregon,(6) which are used extensively for recreation. Of these, 87 have boat launching facilities, and have a total surface area of 40,000 acres. There are also 74 major artificial impoundments with a water area of 113,015 acres(7,8,9,10) Additional information on type and extent of waterways in Oregon is contained in Exhibit 1.

The State of Washington has 2,397 square miles of salt water consisting of 226 square miles of Pacific coastal water, 1,610 square miles of Straits of Georgia and Juan de Fuca, and 561 square miles in Puget Sound.(11) The State has a total saltwater shoreline of 2,656(12) miles, 1,800 of which are located in the Puget Sound.(13) The majority of this is commercially navigable. There are approximately 7,860 lakes and artificial impoundments in Washington, with a total area of approximately 955 square miles; of these, 63 have a surface area greater than 1,000 acres, and account for 735 square miles.(14)

Idaho has no commercially navigable rivers but many of the rivers are used for recreational watercraft activities. At present there are approximately 1,500 lakes and reservoirs in the State with a water surface in excess of 800 square miles.(15) Of these, sixteen have a surface area greater than ten acres and account for 696 square miles.(11) All of these are accessible for boating. (Exhibit 2)

Montana has no commercially navigable rivers in the Columbia River Drainage portion of the state. The total inland water surface is 1,402 square miles.(16) Included in this total are 58 reservoirs with a total surface area of 856 square miles(9) and 1,500 lakes(16) located primarily in the Northwestern part of the State, with 221 square miles(17) of recreational boating area. In addition, there are approximately 32,000 miles(3) of river available to the pleasure boater with the Missouri River System providing most of this mileage.

*coastal rivers defined as those affected by tidal action.

RIVER
SEATTLE
OLYMPIA
WASHINGTON
SNAKE
HELENA
COLUMBIA
PORTLAND
SALEM
CORVALLIS
IDAHO
BOISE
OREGON
RIVER
CONTINENTAL DIVIDE

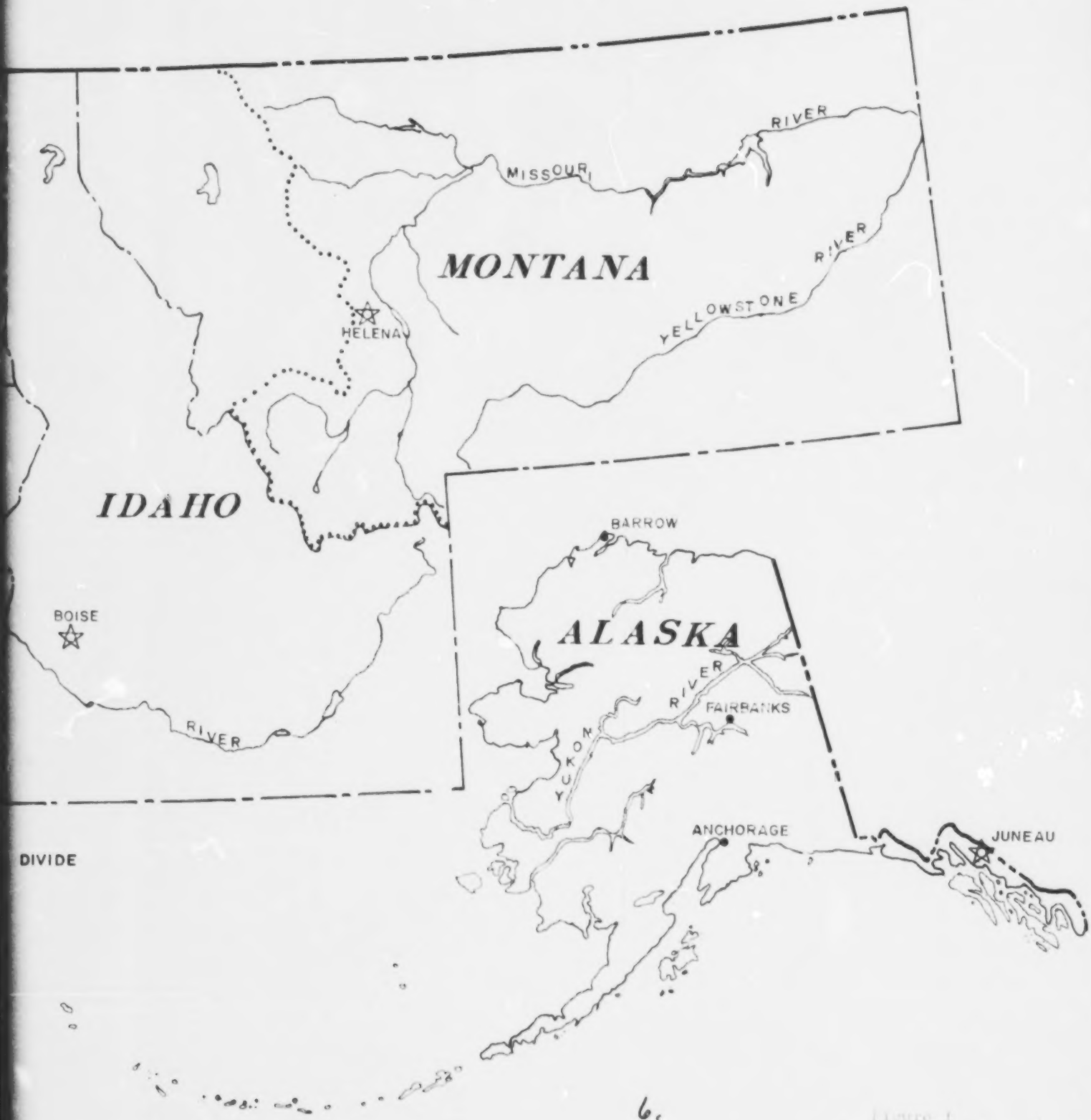

Figure 1
Pacific Northwest

Alaska is virtually surrounded by the sea, having three major seas as boundaries. It has over 30,000 miles of coast line on the Pacific Ocean, Arctic Ocean, and the Bering Sea. Of particular note also is the Inland Passage. Much of this coast is navigable, a major exception being the Arctic Ocean which is frozen most of the year. There are also more than 20,000 miles[18] of commercially navigable rivers. Major rivers are the Yukon-Koyukuk-Tanana River System, the Kuskokwim, Kobuk, and Susitna rivers. Most rivers are frozen a significant part of the year. There are many lakes, but the majority are tundra type lakes which are shallow, and located in marshy flat terrain. Very few of these are used by boaters. Due to the nature of the lakes, and the fact that many are frozen or inaccessible most of the year there are only about 20 major lakes which have significant recreational use.

Recreational Watercraft

Number and Type

Three of the five states in the Pacific Northwest Region require motor boat registration with a state agency, the exception being the states of Washington and Alaska. In Oregon, boats are registered with the State Marine Board; in Idaho it is the Department of Law Enforcement, and in Montana it is the State Board of Equalization. The states of Alaska and Washington depend upon U. S. Coast Guard registration.

In 1966 it was estimated that there are over 313,000 motor boats in the Northwest Region excluding Alaska and an undetermined number of small rowboats, canoes, and prams.[19,20,21,22,23,24] Of this total number, approximately 78 percent are less than 16 feet, 16 percent are 16 to 26 feet, and the remaining 6 percent are 26 feet or larger. Approximately 89 percent have outboard motors. The breakdown by length is of interest because it provides an indication of the number of boats with marine heads. Assuming that 80% of the boats in the 16 to 26 foot class and all those greater than 26 feet have marine heads, there would be an estimated 58,000 boats in the Northwest Region with marine heads. The number of outboard motors is of interest as regards pollution from outboard motor exhaust. Table 1 on the following page provides a summary of these data. Exhibit 3 provides additional information. In Oregon alone, there were an estimated 5,000 recreational boats equipped with marine toilets as of December 31, 1966.[25]

In Alaska, there are over 10,000 boats, registered by the Coast Guard, that are used primarily for recreation. The majority of these are used either on coastal waters or on the Yukon River system. An unknown number of recreational boats are not registered by the Coast Guard. These include boats used on the inland lakes (not required to be registered) and boats used by the natives of Alaska in remote areas. A conservative estimate of native boats would be 4,000. Type of boats found on the coastal waters vary from small skiffs to large pleasure yachts. The majority of the recreational boats are either small cabin cruisers or open run-about types in the length range of 16 feet to 30 feet. The boats on the inland rivers are generally of the square bow "river boat" style, 18 feet to 28 feet long.

TABLE 1

Recreational Watercraft
Pacific Northwest (Excluding Alaska)

State	Under 16 feet		16 to Less Than 26 feet		26 to Less Than 40 feet		40 to 65 feet		Over 65 feet		Total	
	In-Board	Out-Board	In-Board	Out-Board	In-Board	Out-Board	In-Board	Out-Board	In-Board	Out-Board	In-Board	Out-Board
Idaho(20)	183	22,694	1,737	9,032	235	67	2	-	-	-	2,157	31,793
Montana(a)	34	6,209	293	3,081	48	21	3	-	-	-	378	9,311
Oregon(19)	489	51,260	3,475	10,262	1,635	95	115	1	1	-	5,715	61,618
Wash.(b)	164,000		22,300				15,900				26,200	176,000
TOTAL	244,869		50,180				18,123				34,450	278,722

(a) Reference No. 21. These are totals for state, as breakdown of data was not feasible.

(b) Data based upon June 1965 State of Washington Department of Commerce and Economic Development estimate, adjusted to December 31, 1966.

Supporting Shore Facilities

Facilities to support pleasure craft in the Region, excluding Alaska which did not have data in this form, are summarized in Table 2. There are over 1,050 boating sites with approximately 958 boat launching facilities, 337 boat moorages, and 307 fueling and service facilities. Details regarding type and location of supporting shore facilities are contained in Exhibits 4, 5, and 6. Exhibit 7 contains data pertaining to supporting shore facilities in Alaska.

TABLE 2

Recreational Supporting Shore Facilities
Pacific Northwest (Excluding Alaska)

State	Number of Supporting Shore Facilities	Type of Service		
		Number of Ramps	Number of Moorages	Number of Gas & Fuel Service Areas
Idaho[a]	79	66	24	20E
Montana[b]	120	120	36	26
Oregon[c]	618	618	130	136
Washington[d]	234	154	147	125E
TOTAL	1,051	958	337	307

E--Estimated

(a) Reference Nos. (9,35,36,37). Includes reservoirs only.

(b) Reference No. (17). These are totals for state, as breakdown of data was not feasible.

(c) Reference Nos. (4,6,7,8,9,10,28,29,30,31,32,33,34).

(d) Reference Nos. (26 & 27).

Utilization of Various Waters

Coastal

According to U. S. Coast Guard Registration figures, 70% of all boats in the State of Washington are located in the Puget Sound area.(37) Based upon the estimate made by the Washington State Department of Commerce and Economic Development, this represents approximately 205,000 boats. The Sound offers some of the most exciting and interesting areas in the world for pleasure boaters, with the net result that more and more boaters are converging upon this area.(38) The primary recreational use of Washington coastal waters is sport fishing, which is gradually shifting from the Sound to the Pacific Ocean. There are two major

reasons for this shift: Fish catch per angler-day is approximately two or three times as high in the ocean as in the Sound, and the increase in the second hand boat market, along with the increase in the average income, gives more people the opportunity to own a sea worthy watercraft.(39) Washington State has 295 licensed charter boats operating from four ports. These boats all contain marine toilets. In addition there are 1,600 licensed rental kickers (outboard motor boats) on the Puget Sound and Strait of Juan de Fuca.(40) These are open boats of 14 to 18 feet in length and provide no sanitary facilities.

Oregon coastal water boating constitutes nearly 94 percent of small boat activities (less than 21 feet) and nearly 83 percent of the large boat activities (greater than 21 feet).(24) Salmon sport fishing from June through September off the Oregon coast accounts for the majority of this activity. The Oregon State Game Commission makes estimates of the catch, effort, and calculated fishing success in eight major fishing areas along the Oregon coast. In 1965, a total of 535,500 anglers spent approximately 4,139,000 angler-hours on salmon fishing at the eight major areas. The Columbia River area received the greatest use with a total of 251,700 anglers spending nearly 3,000,000 angler-hours. The total number of boats used for coastal salmon fishing in 1965 at the eight areas was 138,120. Approximately 45 percent of this number, or 60,000, used the Columbia River.(41)

Alaska coastal waters are used to a great extent as a highway linking it to Canada and the main portion of the United States, and for fishing. Due to its unique location with respect to the other states, most of the material shipped in and out is by watercraft. Fishing, both commercial and recreational is of major importance, the primary fish being salmon. Sightseeing excursions are also quite popular. Due to lack of roads in many areas, travelers and hunting parties use the coastal waters similar to the way highways are used in the Continental United States. The ferry system is quite extensive, as described later in this report.

Navigable Rivers

The major navigable rivers of the four conterminous states, the Columbia, Willamette, and Snake are commercially navigable year round due to the many dams constructed across their channels. Popular areas for waterskiing and pleasure boating are concentrated generally along the rivers in the vicinity of major population centers. These include the Portland-Vancouver area and Tri-City area on the Columbia River and the Portland area on the Willamette River and the Lewiston-Clarkston and Tri-City areas for the Snake River.

The fishing activity, which is the major boating interest, is generally spread throughout these waters within certain concentrated areas. There is an extremely heavy fishing effort for spring chinook salmon on the lower Willamette River from its mouth to Oregon City, a distance of 26 miles. The Oregon State Game Commission reported in 1965(42) that there were over 74,000 man-days of fishing and an estimated 30,000 to 40,000 boat-days on this stretch of the river for March 1 to May 30, 1965. The 20-year average annual fishing effort for this stream is 91,800 man days with an estimated 40,000 to 45,000 boat-days.(42) Most of the boats used in this area are less than 21 feet in length and have no sanitary facilities.

Another heavy fishing effort is for winter steelhead in areas including the Columbia River from McNary Dam to the mouth; the Kalama, Cowlitz, and Lewis rivers in Washington; and the Alsea, Wilson, Saudy, Clackamas, and Siletz rivers in Oregon.

The major Alaska commercially navigable rivers are the Yukon-Koyukuk-Tanana River System, Kuskokwim, Kobuk, and Susitna rivers. These are used as major transportation routes for personnel and material for non-recreational purposes. They also receive considerable use for fishing, hunting, and sight-seeing. The use of these rivers is increasing annually.

Artificial Impoundments and Lakes

Data have been provided by the U. S. Bureau of Reclamation, Region I, and the U. S. Army Corps of Engineers, Portland District, regarding types of recreational boating at 84 Federal reservoirs under their jurisdiction. These data are felt to be representative of the boating use at lakes, reservoirs, and impoundments throughout the region.

The Bureau of Reclamation has 66 reservoirs under its jurisdiction in the states of Oregon,(18) Washington,(32) Idaho,(14) and Montana.(2) In 1965 there was a total visitor attendance of over 1,600,000 visitor-days(9) related to water usage. Approximately 425,000 visitor-days were spent boating and waterskiing with an unspecified portion of the remaining visitor-days water sport oriented. There was a total of 285,595 powerboat-days and 33,974 sailboat and rowboat days for the 66 reservoirs.(9) These data are summarized in Table 3.

TABLE 3

Recreational Boating Use(9)
Bureau of Reclamation Reservoirs
Region I
1965

State	Number of Reservoirs	Waterskiing Visitor-Days	Boating Visitor-Days	Fishing Visitor-Days	Powerboat Boat-Days	Sail & Row-Boats Boat-Days
Idaho	14	36,055	53,200	123,650	33,565	2,421
Montana(a)	2	400	7,000	7,600	2,500	300
Oregon	18	60,870	131,626	735,218	125,530	13,353
Washington	32	56,000	79,500	312,000	124,000	17,900
Total	66	153,325	271,326	1,178,468	285,595	33,974

(a) These are totals for state, as breakdown of data was not feasible.

For these same 66 reservoirs the total visitor-days use (including non-boating activities) has increased from approximately 2.6 million in 1958 to over 4.6 million in 1965, an increase of 80 percent.(8) Reservoir use in Oregon and Montana showed the greatest increases.

The U. S. Army Corps of Engineers, Portland, Seattle, and Walla Walla districts, have a total 18 reservoirs under their jurisdiction in the Northwest Region. In 1964 it is reported that the total visitor attendance at these 18 reservoirs was 6,533,000 persons.(33) Of this total it is estimated that 25 percent or 1,630,000 were engaged in boating activities.

Regattas

In the Pacific Northwest, boating is a favorite recreational activity of many people and plays an important part in the festivities of certain annual regattas and festivals. Among these are included the Seattle Seafair, the Portland Rose Festival, the Lake Chelan Apple Cup, Lake Couer d'Alene Diamond Cup, the Tri-City Atomic Cup, and the Yukon Marathon Race. At all of these festivals, a great many boats are concentrated into a single area for a period of several days.

Since 1950, Greater Seattle, Incorporated has promoted an annual Seafair celebration. This festival is promoted to focus the attention of vacationists on Seattle during the summer months. The Seafair celebration is climaxed by holding an unlimited hydroplane race known as the "Seafair Trophy" on Lake Washington. During the 1966 Seafair Trophy race an estimated 300 boats were tied up to one spectator boom to witness the race.

The annual Rose Festival held in the City of Portland during one week in June features primarily a rose parade through the streets of Portland. An added feature of the festival are the Navy ships that come into harbor and remain for the duration of the festival. In the 1965 festival there were eleven U. S. Navy ships and two Canadian ships that participated in the festivities, with the number of men aboard these ships estimated at 5,000. All ships are open to public inspection while in port. There are no waste treatment facilities provided for pumping ashore or treatment on board the vessels.

No data are available concerning the number of boats involved in the other festivities mentioned.

Discussion

In 1965 the Oregon State Marine Board conducted a study of pleasure boating and other uses of Oregon waters.(24) It is felt the results of this study are generally representative of pleasure boating in the Region. The study found that average annual boat usage is approximately 46 days for boats under 21 feet in length, 81 days for those over 21 feet in length, and listed the following major activities for pleasure boats: fishing, cruising, and sightseeing, waterskiing, skin diving, and hunting.

The predominant activity of boats less than 21 feet is fishing regardless of type of water location. Over 59 percent of these boaters spend over half their time fishing. This varied from a high of 94 percent for boats using coastal waters to a low of 55 percent for those using rivers. The second major use for boats less than 21 feet was for waterskiing with an average of 16 percent. This varied from 23 percent for lakes and reservoirs to 1.6 percent for coastal waters.

For boats over 21 feet, cruising and sightseeing was the major activity for approximately 49 percent. However, for those using coastal waters over one-half the time, fishing was the predominant activity for nearly 83 percent.

Commercial Watercraft

Ports

There are approximately 65 ports and port districts in Oregon and Washington. The two major ports are Portland and Seattle, and the two primary commercial waterways are the Columbia River and Puget Sound. The locations of these 65 ports are shown in Exhibit 8. In Alaska there are approximately 30 ports and port areas, the major ports being Ketchikan, Wrangell, Juneau, and Anchorage-Nikiska.(43)

Waterborne Commerce

The Columbia River is the chief avenue of waterborne commerce to Oregon and Central Washington. The Corps of Engineers maintains a deep water channel from the mouth of the Columbia River to Portland, some 100 miles upstream. The series of dams and navigation locks that have been constructed or are being constructed by the Corps of Engineers upstream from Portland will provide year around slack-water for commercial shipping from the mouth of the Columbia River to Lewiston, Idaho, a distance of more than 460 miles. The Columbia River upstream from The Dalles Dam has a relatively shallow channel depth and is used chiefly for barge traffic.

Figure 2 shows the commercial shipping tonnage that moved through the mouth of the Columbia River and through the locks upstream during 1964. Commercial shipping upstream from Portland is small compared to the total shipping that takes place from Portland to the Pacific Ocean. Exhibit 9 shows traffic through the locks for the period 1930-1965.

The greatest amount of commercial shipping in the Pacific Northwest occurs in Puget Sound. Total commercial shipping in Washington ports exceeded 42 million tons in 1964 with over 39 million tons of this shipping in Puget Sound. (Exhibit 10) Non-metallic minerals including petroleum products accounts for the greatest part of the total tonnage (Exhibit 11). Commercial traffic through the various waterways and ports of Oregon, Washington, and Idaho are given in Exhibits 12, 13, 14, 15, and 16. Alaska major water commerce is shown in Exhibit 17. Due to the nature of Alaska, there are many small ports and harbors along the cost, which serve as primary supply lines to and from Alaska. All types of commodities are moved, with emphasis upon petroleum and wood products. In addition to U. S. Registry vessel movements, over 2,000 foreign vessels entered Alaskan ports during 1966. Major ports of foreign vessel use and number of foreign vessels cleared through the Bureau of Customs entering Alaskan ports are as follows:

Haines	75	Pelican	92
Hyder	2	Petersburg	69
Juneau	216	Sandpoint	135
Ketchikan	1,134	Sitka	81
Kodiak	79	Skagway	105
Anchorage-Nikiska	152	Wrangell	199
Eagle (Yukon River)	37		

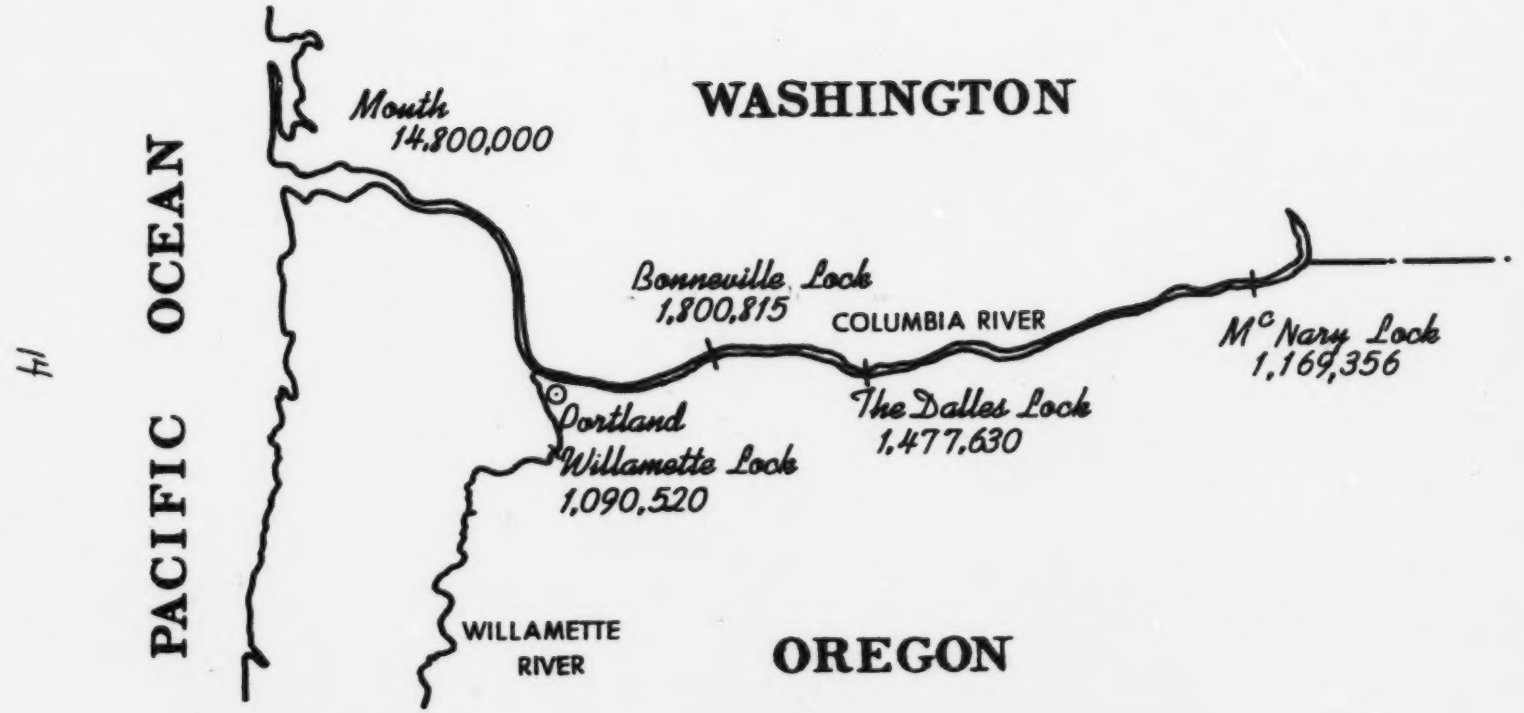

Figure 2

COMMERCIAL SHIPPING ON THE COLUMBIA AND WILLAMETTE RIVERS DURING 1964 (Short tons)
(Data from Corps of Engineers, U.S. Army.)

Table 4 shows the number of commercial vessels that arrived in Portland and Puget Sound during the period 1950-66. As can be seen, shipping is on a slow but steady increase. Of the 1,673 commercial vessels arriving in Portland during 1966, 183 vessels or 15.7 percent were of United States registry. Of the 2,154 commercial vessels arriving in Puget Sound in 1965, 1,054 or 48.9 percent were of United States registry. Exhibit 18 shows the number of vessels and country of registry of the commercial vessels arriving in Portland and Seattle.

The Commission of Public Docks of Portland has reported on the pollution control measures practiced at the Portland Public Docks in cooperation with Police Harbor Patrol. These measures include the following:

a. Daily inspection of under dock and slip water areas at public terminals to detect the presence of floating oil.

b. A report form is logged daily. This report assures that pollution is detected from day to day and an accurate record is available for referral.

c. Maintaining personnel trained in the proper methods of pollution detection and reporting.

d. Close liaison between Commission personnel and the Police Harbor Patrol, U. S. Coast Guard, and the local office of the U. S. Army Corps of Engineers.

e. All inbound merchant ships are routinely boarded by the Police Harbor Patrol and the vessel's master is given a form letter warning that a strictly enforced program is in effect and violation of Municipal or Federal pollution regulations will be prosecuted.

f. At Portland Public Docks, security guards are present when a vessel arrives or departs to immediately report any oil pollution observed upon movement of the vessel.

Reportedly, commercial vessels docking in Portland stay an average of three days. As there is no free anchorage in the Portland Harbor, shipping companies are anxious to move their ships out of the harbor as soon as possible to reduce dock charges. With an average on-board crew of approximately 20 when a vessel is in port, the 1,700 vessels a year docking in Portland would contribute approximately 102,000 man-days of sanitary waste to the Portland Harbor, or a population equivalent to approximately 300 people. Litter and garbage is generally stored on the stern of each vessel during its stay in port and is dumped at sea.

Most of the sanitary waste from Portland docks goes into septic tanks; however, some of the facilities discharge their sewage directly into the river. There

TABLE 4

Commercial Ships Arriving in the
Portland Harbor and Puget Sound by Year*
1950-1966

Year	Number of Ships	
	Portland	Puget Sound
1950	-	1,530
1951	-	1,672
1952	-	1,913
1953	1,438	1,943
1954	1,437	1,953
1955	1,458	1,889
1956	1,510	1,848
1957	1,588	1,889
1958	1,517	2,039
1959	1,534	2,141
1960	1,657	2,278
1961	1,651	2,188
1962	1,662	2,118
1963	1,720	2,098
1964	1,667	2,064
1965	1,747	2,154
1966	1,673	-

*Data from Merchants Exchange, Portland, and the Marine Exchange, Seattle.

are plans to construct municipal sewers to the dock areas. Exhibit 19-30 list the piers, wharves, and docks in the major ports of Washington and Oregon. Sanitary waste from most of these facilities goes directly into the adjacent waterways and probably exceeds the amount of sanitary waste from the commercial vessels.

During the 1950's, the Shaver Transportation Company operated a barge in Portland Harbor to collect bilge waste from commercial vessels docked in the harbor. This waste was barged down the Willamette River and discharged into a lagoon adjacent to the river, where the oil was periodically burned. Problems over inspection of the barge and the threat of fines caused the discontinuance of this service. Air pollution regulations would now prevent burning of oil wastes in this manner. There are presently no facilities for the collection or disposal of bilge waste or tank cleaning waste from vessels in the Portland Harbor. This lack of collection facilities undoubtedly contributes to the discharge of some waste directly into the harbor. No facilities of this type were found at any of the ports in this area.

Commercial Fishing

The Oregon State Fish Commission and the Washington Department of Fisheries have provided reports describing the commercial fishing industry in Oregon and Washington (Exhibits 31 and 32). Commercial fishing vessels commonly are engaged in more than one fishery so that the combined total of vessels incolved in each type of fishery does involve duplication of vessels.

The commercial fishery in Oregon had a total value of $7 million to fishermen in 1964, and the Washington fishery had a value of $18.7 million to fishermen in 1965. Salmon is the most important fishery, accounting for $3.2 million in Oregon in 1964, and $8.4 million in Washington in 1964. Over $5 million of the Washington Salmon fishery was landed in Puget Sound and $1.2 million were landed in the Columbia River ports. Over 800 vessels are utilized in the Oregon salmon fishery with most of the vessels operating out of Coos Bay and Astoria. Exhibit 31 shows the approximate distribution of the commercial salmon fleet. The Washington State fishing fleet consists of approximately 3,900 boats and is distributed approximately as shown in Exhibit 33.

The Alaskan Fish and Game Department has licensed approximately 10,000 fishing boats of all types. The majority of these are operated for the salmon fishery which exceeds that of Washington and Oregon. The others are used primarily for the crab and herring fisheries. Supporting this fleet are a number of floating canneries which discharge waste directly to the waters. The King Crab canneries operate year round, while the salmon canneries are a summer operation. Commercial fishing licenses on the Yukon number only 531.

Governmental Watercraft

Federal Watercraft

The following Federal Agencies have vessels operating in the study area. Details as to location, number, and description of vessels and type of waste disposal systems are presented in Exhibit 34.

Department of the Interior

In the four conterminous states the Department of the Interior has approximately 25 boats and ships. The Northwest Regional Office of the Federal Water Pollution Control Administration(44) has a total of eight boats which are used routinely in water sampling activities. These vessels range from outboards to a 45-foot oceanographic vessel. Only the oceanographic vessel has a head, and it is equipped with a macerator-chlorinator device. The U. S. Geological Survey(45) presently has two boats in their operations but are purchasing a third in the near future. None have heads but a chemical toilet may be added to the proposed vessel. The Bureau of Sport Fisheries and Wildlife(46) has a few outboard and many rowboats located throughout the region, none of which have heads. The regional office of the Bureau of Commercial Fisheries(47) has a 223-foot supply vessel and two research vessels, 93- and 177-feet long. These three vessels all with heads, and have a total crew capacity of 37. One of the vessels has a holding tank and the heads of the other two are not used when the vessels are moored. The Bureau of Land Management(48) has one 14-foot outboard in Boise, Idaho, which does not have a head.

The Department of the Interior in Alaska has approximately 200 boats and ships, with 176 belonging to the Bureau of Commercial Fisheries, and 23 to the Bureau of Sport Fisheries.(49) Many of these boats have sanitary facilities, but none are known to have treatment facilities.

Department of Defense

Within the four conterminous states, the U. S. Army Corps of Engineers has vessels under the control of three districts. The Portland District(50) presently has a total of 12 dredges and smaller boats used in district operations. These include four hopper dredges, three pipeline dredges, one booster barge, two tugs, one survey boat, and one launch. The 12 craft have a total crew capacity of 385. All of the vessels have sanitary facilities and none presently provide treatment. Treatment facilities for all vessels are scheduled by Fiscal Year 1968. The Walla Walla District(51) has small boats, 8 to 45 feet, which are used primarily in surveys, reservoir management, and quality studies. Only one vessel is reported to have a head. The Seattle District(52) has two survey boats, a derrick barge, and a snagboat. These four craft have a total crew capacity of 31. Each vessel is equipped with central maceration-chlorination treatment or a maceration-chlorination package plant. No information was obtained pertaining to Corps of Engineer boats in Alaska.

The U. S. Navy(53) is represented in this area by the 13th and 17th Naval Districts. One destroyer and two destroyer escorts with a total crew capacity of 140 are based in the Puget Sound area. Occasionally a tug, a submarine, and a transport with a total crew capacity of 455 are also in the area. There are also six ships located in Alaskan ports with a total crew of 136 men.

When a ship enters the Bremerton Ship Yards for servicing, it spends approximately one-third of its servicing period on dry dock. While there, only one-half of the crew remains aboard. All waste, oil, garbage, and trash is disposed

of to shore facilities, with sanitary wastes going into the waters. Navy regulations specify one head for approximately 16 men. No recently built ship has either a treatment system or holding tanks.

Department of Commerce

The U. S. Coast and Geodetic Survey(54) maintains six vessels which are moored on Lake Union in Seattle. The vessels, ranging in size from 90 to 292 feet, are used for hydrographic purposes. While at sea the crafts have a total crew capacity of 261 and a capacity of 237 while moored. Only one vessel has a holding tank. The moorage at Lake Union is equipped to handle sewage effluents from its vessels and the vessels are moored from 25 to 50 percent of the time. There are also four ships(49) located in Alaska during the summer months, with a total ship's complement of 228. These ships have sanitary facilities, but no treatment.

The U. S. Maritime Administration(55 & 56) maintains two mothball fleets in the Pacific Northwest. A fleet of 66 vessels with a total maintenance crew of 32 is maintained in Astoria, Oregon, and a fleet of 117 vessels with a total maintenance crew of 81 is maintained in Olympia, Washington. One privy is provided for each row of vessels; this waste, chlorinated at Olympia and untreated at Astoria, is eventually discharged to the water. The working barges and tugboats have sanitary facilities, but none provide treatment. The vessels in the mothball fleet are painted every two years; rust scale and oil paint are allowed to fall into the water. There is no attempt to recover waste paint during painting operations at Astoria, whereas the water is swept with burlap at Olympia to recover the waste paint. Refuse and oil at both locations are collected in barges and burned. The Northwest Regional Office of the Federal Water Pollution Control Administration(56) has been working with the U. S. Maritime Commission in an attempt to resolve water pollution problems associated with these fleets.

Department of Agriculture(49,57,58)

The U. S. Forest Service has three small outboard and one pontoon boat used on various lakes and reservoirs in Idaho. They also maintain about 24 boats in Oregon and western Washington. These are all small boats with no sanitary facilities. In Alaska they have 41 boats, some of which have sanitary facilities, but no treatment.

Treasury Department(49,59)

The 13th U. S. Coast Guard District operates approximately 187 vessels in Washington and Oregon ranging in size from 10-foot dinghys to 269-foot cutters. Twenty-two of these vessels are larger than 65 feet and have a total crew capacity of 1,241. Sanitary facilities but no treatment are provided in these larger craft. Heads are provided in 26 of the 165 craft smaller than 65 feet. Maceration-chlorination treatment is provided in all of the 44-foot motor lifeboats. In Alaska there are also 15 boats and ships with a total complement of 664 men. Some of these vessels have sanitary facilities but none have treatment

State Watercraft

The following State agencies have watercraft that are operated in the study area. Details as to locations, number and description of vessels, and type of waste disposal systems are presented in Exhibit 35.

Idaho had 93 boats licensed at the State level as of January 1, 1967. About 40 of these are located at the various sheriff's offices and most of the remainder are owned by the Fish and Game Department and the Department of Law Enforcement. None of these are known to have heads.(60)

In the State of Washington the Department of Game(61) maintains 114 boats, 149 outboard motors, and 83 boat trailers, none of which have sanitary facilities. The Department of Parks and Recreation(62) maintains five boats, and the Department of Fisheries(63) maintains 33 boats, ranging from 12 to 80 feet in length. Three of the larger boats have sanitary facilities but none provide treatment. The Washington State Ferry System(64) operates 20 ferries in the Puget Sound area, and conducts 98 percent of all ferry business in the area. Each vessel has sanitary facilities, but no treatment systems are provided. In 1965, over 5,000,000 passengers were carried on these vessels. The majority of the 18 terminals have sanitary facilities. Four terminals discharge their wastes to city sewers while seven have holding tanks and chlorination systems. Details are presented in Exhibits 16 and 36.

The State of Oregon has a considerable number of state-owned watercraft, but specific numbers were not obtained. Most of these are small boats with no sanitary facilities; but, size ranges up to the 180 foot Yaquina which does have sanitary facilities for a crew of 20 men. None of the craft have treatment facilities.

No information was obtained regarding the number of watercraft belonging to the State of Montana.

Total number of boats owned by the State of Alaska(49,65) was not available but the Department of Fish and Game has a total of 17 boats. Some of these boats have sanitary facilities, but none have treatment. The Alaska Ferry System operates a total of five ferries, each with a capacity of 500 passengers and 108 automobiles. Three ferries operate between Prince Rupert, British Columbia, and Skagway, normally making five stops in between. There are four sailings each week in the "off" (winter) season with sailings more frequent during the tourist season. There are two additional state ferries serving South Central Alaska, one serving Cordova and Valdez, with sailing twice a week from each port; and the other ferry serving Seward, Valdez, Cordova, Port Lions, Kodiak, Seldovia, and Homer. These ferries have sanitary facilities, but no treatment, discharging directly to the waters.

Residential Watercraft

Findings of the Houseboat Pollution Study being conducted at the Pacific Northwest Water Laboratory, Technical Services Branch, indicate that in the states of Idaho, Washington, and Oregon there are approximately 1,200 floating homes used as part-time or year-round residences, with an estimated resident

population of over 2,000 persons. These are commonly referred to as houseboats and formally defined as habitable floating structures not equipped with power. The year-round residential dwellings have the normal types of facilities found in land homes including toilets, baths and/or showers, laundry facilities, kitchens, etc., and wastewaters are discharged without treatment to the waters over which they are moored. The small part-time residences of floating shacks use them for weekend retreats, hunting, and fishing. These are moored year-round where used and may or may not have sanitary facilities.

There are 645 houseboats in Oregon, with an estimated permanent residence population of 1,050 persons, located primarily in the vicinity of Portland on the Willamette and Columbia rivers, the vicinity of Astoria on the Columbia River, and on Howard Prairie Reservoir in Jackson County.

In Washington there are an estimated 525 houseboats with a population of nearly 980 persons. Approximately 500 of the houseboats are located in the Seattle area on or near Lake Union with the remaining 25 located near Vancouver on the Columbia and Lewis rivers.

There are approximately 30 to 40 houseboats on Lake Pend Oreille in Idaho. Figure 4 illustrates the location of the houseboats in states of the Pacific Northwest Region.

Alaska has numerous vessels moored at harbor facilities, especially in southeast Alaska, which serve as living quarters. Sewage from these is discharged directly to the waters. Sixty-eight people live on such vessels in Juneau, but no information is available on other numbers or locations.

WATERCRAFT POLLUTION

Recreational Watercraft

These contribute the following types of waste: trash, garbage, debris, sewage, and gasoline and oil by-products resulting from incomplete combustion of fuel.

A documented instance of water pollution was not found in the Pacific Northwest which could be attributed solely to recreational watercraft. A letter from the Montana State Board of Health, dated December 23, 1966, stated they had found a slight increase in coliform in a few bays on Flathead Lake, the State's largest natural lake (Exhibit 6,37), but they did not know whether this concentration was due to boats or some onshore activity. These bays have not shown similar increases since the passing of the new boating law which requires all boats equipped with marine heads to be further equipped with a holding tank or other satisfactory treatment. However, since the law has been in effect less than a year it is doubtful that there is any correlation.

Data are not available on the quantity of trash and garbage generated by boaters, but this is the most visually apparent pollution problem resulting from pleasure watercraft. Concern over this was expressed by every organization contacted, which was responsible for maintaining or using water recreational areas. A letter (Exhibit 38) from Oregon's Marion County Sheriff's

Figure 3
Houseboat Locations
Oregon, Washington, and Idaho

Office, states that their skin diving team has reported that trash and garbage literally cover the stream and lake bottoms in the vicinity of certain boat moorages and popular fishing areas. Although trash and garbage found floating on, deposited in, and adjacent to the waters may not necessarily be due to pleasure boaters, it is still generally agreed that they do contribute their share of litter. This problem area is expected to become more significant if corrective measures are not initiated.

Exhibit 39 is a proposed study to be conducted by the University of Washington entitled "Bacteriological and Esthetic Effects of Pleasure Boat Waste Discharge on Small Harbors." The objective of this study will be to determine and document the pollution problems caused by the waste discharge from small pleasure craft in two small (one fresh water, one salt water) harbors in the State of Washington. It is probable that large marinas and congested recreation harbors could produce public health hazards due to fecal discharge from pleasure watercraft. Since little data is available pertaining to this subject, this study seems to have merit.

Pollution from boat motors occurs due to increased turbidity of a shallow body of water through increased turbulence, and the addition of oil, gas, lead, and other additives through the motor exhaust. English(66), in 1963, found in laboratory studies that the average percentage of fuel constituents found in outboard motor exhaust were as follows: non-volatile oil, 54%; volatile oil, 2%; and lead, 22% based on a figure of 2.6 grams of lead per gallon of gasoline. English also demonstrated in a field study(67) that tainting of fish flesh occurred at a threshold level of combined fuel-use of 8 gallons/million gallons of water and a daily fuel use rate of 0.17 gallons/million gallons of water. Data provided by the Corps of Engineers, Portland District, on boat use at seven of their reservoirs in Oregon(8), was used to calculate the theoretical ratio of gas consumption to reservoir volume of water. Assuming 3.5 persons per boat and 3 gallons of gas used per day per boat, together with peak boating use figures, the most critical reservoir was Fern Ridge (Exhibit 1) with a maximum daily fuel use ratio of 0.065 gallons/million gallons of water. This indicated that boat usage could increase by a factor of over 2.5 before problems with fish flesh tainting might occur. At the current rate of boating growth in Oregon, this level would be reached in approximately 25 years.

Commercial Watercraft

The major sources of water pollution from commercial vessels are: pumping of bilge waste, accidental spills of cargo and fuel during dock operations, and discharge of sanitary wastes, trash, garbage, and debris. The problems resulting from the above sources are generally in direct proportion to the disposal facilities or lack of facilities at the ports, and the volume of port traffic.

According to the 13th Coast Guard District, Oregon and Washington commercial shipping resulted in 51 water pollution investigations during the period January 1, 1965, to December 31, 1966. Oil spills accounted for 42 of these cases, while flushing of cargo tanks and the dumping of refuse into the harbors comprised the other nine. Exhibit 40 lists all of the investigated water pollution cases for the stated period. A breakdown of these cases by ports

indicates that Portland, Oregon, had 61 percent of the investigated cases; Seattle, Washington, 16 percent; and the remaining 23 percent occurred in other ports. Personnel at the 13th Coast Guard District stated all of their records, regarding watercraft pollution investigation prior to January 1963, are located in the U. S. Coast Guard Office, Washington, D.C.

The states of Idaho and Montana reported no investigations regarding commercial watercraft pollution.

The Alaska District Corps of Engineers provided information pertaining to seven investigations occurring in Alaska between July 6, 1956, and January 3, 1967. (Exhibit 41) A special report prepared by the Alaska District Corps of Engineers on total water pollution is included as Exhibit 42.

A special report prepared by the Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior, on the loss of marine life incidental to stranding of a petroleum barge at Moclips, Washington, on March 11, 1964, is included as Exhibit 43. The report states that on March 16, 1964, more than 500,000 gallons of fuel, consisting mostly of diesel oil, was pumped into the surf in efforts to free the barge. As a result, an estimated several tons of clams were killed along with an undetermined number of other forms of marine and wildlife.

Exhibit 44 is a report of a specific instance of a cargo tank flushing. It is entitled "Engineering Report on the Butterworthing of the HAWAIIAN RANGER at Terminal 4, June 15, 1966." This report was prepared by the Oregon State Sanitary Authority to determine the effects of Butterworthing upon the receiving body of water. Butterworthing is the name of a process used, upon completion of discharging molasses to shoreside storage tanks, to remove the residue remaining on the sides, floor plates, and heating coils of the cargo tank. These tanks are cleaned with 1,300 to 1,900 gallons of water heated to 170° F, which is sprayed around the tank. The resulting mixture of molasses and water is pumped overboard through a canvas sock. The Oregon State Sanitary Authority took DO (Dissolved Oxygen) and BOD (Biochemical Oxygen Demand) samples of this mixture as it came from the tank, from the canvas sock, and at the stern of the ship. Based upon these samples it was determined that "unless better control can materially reduce the amount of waste to be discharged to the Willamette River, that Butterworthing in the Portland Harbor should be prohibited, unless it is discharged to a land-based sewer where adequate treatment can be provided."

Floating canneries for salmon and King Crab may become a serious pollution problem in certain areas of Alaska. Salmon canneries operate during the summer months, and the King Crab canneries are in operation most of the year. In Kodiak there were five floating canneries in January 1967, each dumping all their waste and by-products from the crab canning directly into the harbor. (Exhibit 45) How significant this becomes will depend upon the trend in commercial fishing.

Governmental Watercraft

Federal government vessels have been responsible for three specific watercraft pollution cases which were investigated during the period January 1, 1965, to

to December 21, 1966.(Exhibit 40) One of these cases was caused by painting the Reserve Fleet at Olympia, Washington, and the other two were oil spills. In all instances, the organizations involved took corrective action.

On June 22, 1966, the Federal Water Pollution Control Administration recorded a serious reduction in dissolved oxygen at their Pollution Surveillance Station No. 124, located on the Willamette River in Portland, Oregon. The U. S. Army Corps of Engineers, Portland District, was conducting dredging operations at a point 1-3/4 miles upstream from the station. The dredging operation was considered responsible for the oxygen drop. A survey was conducted by the FWPCA Portland staff on June 30, 1966, in the area of dredging operations.(Exhibit 46) The results of this survey indicated significant quantities of bottom sludge deposits in the dredging area. If these deposits were disturbed in the dredging operation it would have been possible for this suspended organic matter together with the low flow and temperature conditions of the river to produce the measured oxygen drop. It is now the practice of the Corps to schedule its dredging operations in an area of sludge deposits during high flow period to minimize the possibility of further dissolved oxygen reductions. Proper scheduling of all dredging operations and other necessary steps should be taken to avoid the recurrence of problems of this type.

Exhibit 47 lists the U. S. Army Corps of Engineers, Portland District, average annual volumes of dredging, along with their spoil areas on the various rivers and harbors throughout their district. The majority of their dredging occurs on the Columbia and Lower Willamette rivers. Exhibit 48 is the dredging schedule for the Seattle, Washington, District of the U. S. Army Corps of Engineers. Their dredging operations are primarily located in the Puget Sound harbors. No water pollution problems other than the one reported previously have been attributed to these operations.

Many governmental vessels using the ports of the Pacific Northwest Region are large and carry a large crew. Thus when in port, these vessels discharge large volumes of sanitary waste. Concern has been expressed by the Oregon State Sanitary Authority and other agencies regarding raw sewage disposal from the Navy and foreign vessels brought into Portland Harbor for the annual Rose Festival. It is estimated that there are between 5 and 10 thousand men in the ships for the five days of the festival. While no data have been collected to document a pollution problem, the potential problem in this instance is evident.

Residential Watercraft

There are approximately 1,200 houseboats, located in the states of Washington, Oregon, and Idaho. These houseboats are the residences of an estimated 2,250 people who discharge their waste without treatment to the nearest water.

The Pacific Northwest Water Laboratory Technical Services Program is presently conducting a special study on houseboat pollution for the State of Oregon. It is calculated that the waste discharge from these houseboats is 31 million gallons per year with a total organic loading of 64,000 pounds of BOD per year.

Bacteriological and biological data have been collected in the vicinity of houseboat concentrations in the Portland area. These data indicate minor pollution conclusively attributable to houseboats. The potential public health problem from these wastes has been recognized by the Oregon State Sanitary Authority and abatement of this practice is required by September 1967.

In the State of Washington, at the present time, there are an estimated 525 houseboats. Lake Union, in Seattle, receives untreated discharge from 500 of these units and is a relatively shallow, stagnant body of water. The rate of flow through the lake is regulated by the number of lockages at the Government locks. While no data have been collected to confirm water pollution attributable to these houseboats, it is believed that a problem does exist and corrective actions have been taken by both the City of Seattle and King County Health departments. All houseboats in the city and county are being required to connect to city sewers. The houseboats along the Columbia and Lewis rivers presently provide no treatment facilities. No corrective actions have been instigated as the problem has been considered minimal.

In the State of Idaho there are between 30 and 40 houseboats located on Lake Pend Oreille, all of which discharge untreated wastes.

There are also numerous vessels moored at the harbor facilities in Southeast Alaska that serve as living quarters. Sanitary waste from these boats is discharged directly into the harbor.

METHODS AND NEEDS FOR CORRECTING POLLUTION

Existing Methods

Sewage

Seven basic schemes are in use today for correcting pollution due to liquid waste disposal from watercraft and shore-supporting facilities. These seven schemes are listed below:

a. Holding tanks
b. Maceration-chlorination
c. Incineration
d. Small package plant
e. Connections with city sewers
f. Septic tanks with subsequent chlorination
g. Disposal at sea

Holding tanks are not widely used today but appear to offer one of the best methods for solution of the problem, especially for small craft. Their big advantage lies in the fact that they discharge nothing to the water. Disadvantages are that unless they are "designed" into the boat, modification may present significant problems. They may be aesthetically objectionable due to odor; and, if widely used, many shore facilities must be provided for manually emptying or pumping them out. One commercially available holding

tank system was found. This system was a self-contained, electrically operated, recirculating flushing toilet. Space requirement for this system was little more than for conventional marine toilets. The cost to the boat owner for this system ranges from $100 to $235. Holding tanks are currently being used by the Coast Guard on some of their smaller craft and by the Coast & Geodetic Survey on one of their large 292-foot survey ships which is moored on Lake Union, Seattle, Washington. The Oregon State Sanitary Authority is presently looking most favorably at the holding tank method for small craft (Exhibit 49). The State of Montana is also heavily in favor of the use of these systems as their laws require the use of a holding tank or a treatment system equivalent to secondary treatment.

Macerator-chlorinators are becoming quite popular. Some ten firms throughout the United States manufacture the unit which ranges in price from $90 to $130. Most of these devices consist of two chambers. The waste enters the first chamber, is ground up and sodium hypochlorite is added. It next goes through a small detention tank and is then discharged. The advantages of this system are that these units take up little space and are easily installed on present facilities. The biggest disadvantage lies in the fact that the boat owner is solely responsible for the correct operation of the system. Should the macerator quit functioning or the supply of disinfectant run out, the unit continues to work but a completely unsatisfactory effluent is discharged. Many studies have been carried out on these devices. One worth noting was published by the New York State Department of Health in 1962.(68) This study concluded that these units were effective in treating fecal sewage but the degree of treatment was dependent on variables such as load, amount of chlorine added, amount of grinding, dexterity of human manipulation, and environmental variables such as pH, temperature, etc. The State of Montana prohibits the use of these devices and the Oregon State Sanitary Authority does not consider them as acceptable (See Exhibit 49). The Department of the Army, as of October 1965, printed a regulation prescribing treatment using the maceration-chlorination technique on vessels with a normal complement of from 1 to 24 men (Exhibit 50) An additional report on marine toilets using macerator-chlorinators can be seen in Exhibit 51.

Incineration offers another method of treatment. These devices have become popular for treating wastes from trailers and campers. Basically the wastes are subject to intense heat generated by a power burner run on bottled gas. The waste is then vented to the air, and, according to the manufacturer, an invisible, odorless vapor is formed. Two units found in the literature sell for approximately $300 each. Their biggest advantage lies in the fact that the incinerators return nothing to the stream. However, they require a source of power as well as storage space for bottled gas. The Oregon State Sanitary Authority states that units which return nothing to the stream would probably be acceptable.

The fourth scheme is the use of small package plants. These are usually aerobic treatment systems and can be used either on board vessels or by supporting shore facilities. Their biggest use today is probably by the supporting shore facilities. These units can be either of the floating type or mounted on dry land. They offer an excellent treatment system for a marina in an outlying

area where connections with city sewers are not feasible. The Army specifies this type of treatment for their craft with a complement of 25 or more (See Exhibit 50).

Connections with city systems offer the best solution for supporting shore facilities and for shore-based watercraft, such as houseboats. Examples of this type of disposal can be found in the Pacific Northwest. Of the 18 terminals used by the Washington State Ferries, four are currently connected to the city system (Exhibit 36). The Naval Shipyard at Bremerton connects ships in dry dock to the Bremerton system and the Coast & Geodetic Survey shore facilities on Lake Union are also connected to the city system which facilitates the pumping of the holding tanks on their vessels.

Septic tanks with subsequent chlorination are used by 7 of the 18 terminals in the Washington State Ferry System (See Exhibit 36). While this system does not offer extremely good removal, it is an improvement over practices of dumping raw sewage into receiving waters. Certain ships are reportedly equipped with central collection systems and septic tanks, and studies have been undertaken using activated sludge systems, but none were seen in the area.

The last method is disposal at sea. While this method does not reduce the amount of pollutants entering our waters, it does help the problem in our harbors.

Trash, Debris, and Garbage

Personnel on small boats normally carry bags or other containers for later disposal at marinas, docks, or at home; or, in some instances throw it overboard. While at sea this is probably the more common method. Some ships and large boats discard indiscriminately; but, many discard when at sea and store while entering or in port, discharging to shoreside facilities.

Oil and Bilge Waters

These are generally pumped while at sea. However, this is not always feasible. Since shore facilities for collection and disposal of these wastes are practically non-existent, the ship's master may have no recourse but to discharge to the harbor or river. The Alaska District Corps of Engineers have special recommendations regarding pollution from oil and bilge (Exhibit 42). Accidental discharge due to human ignorance or a true accident also occurs.

Needs

The needs for pollution control from watercraft and supporting shore facilities are many. In many cases all that is needed is utilization of equipment and knowledge available. Other cases require additional research. In any case, the Federal Government should lead the way in developing and adopting efficient treatment programs for their watercraft and shore facilities. This in effect

is being done. A few of the agencies to lead the way are the Corps of Engineers, the Maritime Administration, U. S. Navy, and U. S. Coast Guard (See Exhibits 34,50,52). The Corps of Engineers is specifying maceration-chlorination for some of their craft, and may conflict with existing laws or laws to be enacted.

Sewage

Small watercraft are in need of an efficient, reliable, inexpensive treatment facility which can be used as an alternative to holding tanks. Also needed, if holding tanks is the method of choice, are additional supporting shore facilities for collection and disposal of these wastes.

Ships need improved design of internal collection systems which will meet stringent requirements pertaining to watertight compartments. Additional work is necessary on the design or modification of holding tanks, package plants, and other aerobic or anaerobic systems to meet the needs of these large watercraft, and other watercraft such as houseboats and dredges. The Navy is vitally interested in this approach as they don't consider dockside collection systems as practical for the many waste discharge points in Naval ships (Exhibit 52). Work should also be done in cooperation with shipbuilding firms to design new ships so that either holding tanks or treatment systems could be employed.

Finally, there is a need for supporting shore facilities for the collection of liquid wastes from ships. This waste, plus the waste from shore facilities, must then be properly treated. Facilities are also necessary for the collection and treatment of wastes generated from cleaning of cargo space, "Butterworthing," and other similar procedures.

Trash, Debris, and Garbage

The biggest need in this area is for the provision of adequate shore-based collection facilities and an extensive educational program. Also desirable would be work on developing containers which degrade, but the effort seems to be in the opposite direction; aluminum cans, glass, plastic containers, aluminum foil, all of which do not degrade, are becoming more prevalent.

Oil and Bilge Waters

Ships should be designed so that these materials can be pumped to a supporting shore facility. The supporting shore facility in turn needs a suitable collection system with suitable disposal so as not to cause water or air pollution. This is particularly significant as materials of this type normally are not permitted to enter municipal sewers. It would also be desirable to develop low head oil collectors or filters which could be used aboard ship to remove oil from bilge water or other oil bearing waters.

Additional work is also needed to develop new methods for mopping or cleaning up oil and other materials resulting from accidental spills

LEGISLATION

Existing

In the Pacific Northwest there are a number of laws and regulations that either do or could apply to water pollution attributable to watercraft and supporting facilities. These have originated at local, State, and Federal levels of government as well as in Canada and at the international level.

Local

The City of Portland, Oregon, has ordinances (Exhibit 54) prohibiting the discharge of garbage, refuse, and oil in the Portland harbor and immediate vicinity. In 1944, the City of Seattle, Washington, passed an ordinance (Exhibit 55) prohibiting sewerless houseboats on Lake Washington. Twenty years later another ordinance (Exhibit 56) was passed which prohibits the dumping or throwing of garbage or refuse into the waters from houseboats.

State

State laws and regulations in the Pacific Northwest vary markedly. Idaho, Washington, and Alaska are at one end of the spectrum with no specific laws or regulations pertaining to watercraft waste disposal. However, these three could use other existing water pollution control regulations (Exhibit 57,58,59) for pollution abatement if necessary. At the other end of the spectrum is Montana, which in 1966 passed a law (Exhibit 60) requiring all watercraft with toilets to use holding tanks, or treatment devices capable of accomplishing the equivalent of secondary treatment. The Oregon Legislature adopted Senate Bill No. 185 (Exhibit 61) in 1965, which has now become a part of Oregon Revised Statutes (ORS 449.150). This law became effective September 1, 1967, and it provides for the abatement of all sewage and garbage pollution sources including houseboats, moorages, marinas, and other waterbased buildings and structures. In addition the Oregon State Marine Board has regulations (Exhibits 62,63) governing the use of marine toilets on eight lakes in Deschutes County. Toilets must be sealed, or provide treatment "to render waste harmless."

Federal

Several Federal agencies have some jurisdiction over waters in the Pacific Northwest. The National Park Service has regulations (Exhibit 64) covering park waters. They prohibit the dumping or discharging of wastes, garbage, and refuse in freshwater bodies, except the Great Lakes. In salt water and the Great Lakes the dumping is prohibited within one mile of the nearest shore. National Forest supervisors have the authority under Regulation U-6, Department of Agriculture, to restrict use of National Forest lands when deemed necessary to safeguard public health, welfare, safety, or convenience. Exhibit 65, an example of a regulation safeguarding public health, requires the sealing of all "heads" on cabin cruisers launched on Diamond Lake in Oregon.

The U. S. Army Corps of Engineers has regulations (Exhibit 66) governing the use of houseboats, boathouses, etc., on their reservoirs. Discharge of sewage

and garbage from any watercraft is prohibited except in accordance with State and local regulations. Refuse and rubbish cannot be thrown on reservoir waters or adjacent land, but must be disposed of at designated places. The U. S. Army Corps of Engineers also published Regulation No. 1125-2-302 (Exhibit 50) in October 1965. This regulation requires the installation of sewage treatment devices on Corps floating plants involved in civil works functions.

One of the more extensive Federal laws is the River and Harbor Act of 1899 (Exhibit 67). It prohibits the discharge of refuse into any navigable water of the United States.

The Oil Pollution Act of 1924 (Exhibit 68) makes it unlawful to discharge oil by any method, means, or manner into or upon the coastal navigable waters of the United States. State and Federal laws related to oil pollution of the Puget Sound area are summarized by the Department of the Navy in SOPA Puget Sound Instruction P5400.1A (Exhibit 69). The Oil Pollution Act of 1961 (33 USC 1001-1015) implements the provisions of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954.

The Federal Water Pollution Control Act P. L. 84-660, as amended, also provides certain general guidelines which could apply to watercraft, but primarily is an enabling act which authorizes and directs action by governmental agencies.

Canadian

The Canadian Shipping Act, Oil Pollution Prevention Regulations of 1960, plus amendments, are shown in Exhibit 70. Due to the proximity of Canadian waters, this law can have effect upon some United States waters and shores, and in general, is quite similar to the United States law.

International

International regulations can also have considerable effect upon our shores and waters and one with considerable potential effect is the 1954 International Convention on Oil Pollution at Sea. Signatories to this convention are Belgium, Canada, Denmark, Finland, France, Federal Republic of Germany, Iceland, The Netherlands, Norway, Poland, Sweden, and the United Kingdom; and, as of 1961, the United States. This regulation establishes rules regarding the discharging of oil and oil containing wastes on the high seas, and permits establishment of areas restricted to dumping.

Proposed

Private Organizations

Two model acts are also included. Exhibit 71 is a "Model Act on Sewage Disposal from Boats" by the Outboard Boating Club of America and Exhibit 72 is a "Model Act to Prohibit Littering and the Disposal of Untreated Sewage from Boats" by the National Association of State Boating Law Administration.

State

The State of Washington Department of Park and Recreation Commission has two new proposed regulations before the 1967 State Legislature. They read as follows:

Section 46: The discharge of garbage, rubbish, or debris from boats on the waters of this state is prohibited.

Section 47: "In addition to the powers and duties otherwise provided in this chapter, the Commission shall have the power and duty to make rules and regulations regarding marine toilets and their use consistent with the prevention and control of pollution of the waters of this State and not in conflict with the rules and regulations of the State Department of Health or the Pollution Control Commission." Washington also has an Interclub Association (Yacht clubs) with a Litter and Pollution Panel. They presented a list (Exhibit 73) of possible methods to combat litter and pollution from watercraft.

Federal

The Bureau of Reclamation, Region 1, Boise, Idaho, is starting to include a clause pertaining to boats in lease agreements with other Federal and State agencies. In a draft(69) of such an agreement the clause reads as follows:

"h. The State shall post the following notice at all boat launching and docking facilities located on and around Spangler Reservoir:

NOTICE

Watercraft using Spangler Reservoir shall not dump trash or sewage into the waters thereof. All trash and sewage shall be disposed of on shore in accordance with State and County sanitation regulations.

Launching and use of houseboats and of any craft equipped with flush-type toilet facilities upon the waters of Spangler Reservoir is prohibited."

It is planned to include a similar clause in all new lease agreements made by Region 1.

Exhibit 74 is a "Proposed Policy of Sewage and Waste Disposal from Vessels" prepared by the Division of Environmental Engineering and Food Protection, U. S. Public Health Service. It presents proposed effluent standards for interstate traffic under the terms of the Interstate Quarantine Regulations. One set of standards is for vessels with a normal complement (passengers and crew) of over 40 and another set for vessels with a normal complement of 40 or less.

Needed

Enforcement of the laws presently in effect is difficult, and is generally poor. Lack of personnel and funds is given as the primary reason. However, if all of the laws and regulations were enforced, there would still be confusion due to lack of conformity which exists.

Oil and oil-containing material appear to be covered adequately. One barrier to the proper functioning of oil discharge laws is the lack of supporting shore facilities. Facilities, where oil and oil containing wastes can be

readily collected and eliminated without causing additional water or air pollution, are virtually nonexistent. Therefore, if a ship does not or cannot discharge these wastes at sea, they have no alternative but to pump them into a harbor or river.

Appropriate laws should require the provision of supporting shore facilities for the collection and disposal of oil and bilge waters.

Sewage disposal, including wash waters, regulations are at great variance and should be made as consistent as feasible. Model laws should be developed, based upon valid scientific studies. Federal laws and regulations should be patterned after these, and the model laws should be presented to the states for their consideration.

Trash and garbage regulations have somewhat more consistency. The discharge of these from boats and ships, should be prohibited, unless on the high seas, or macerated and passed through an acceptable treatment system.

BIBLIOGRAPHY

1. Areas of United States, Bureau of the Census, Department of Commerce, U. S. Government Printing Office, 1942.

2. 1960 Census. World Book Atlas, Field Enterprises, Educational Corp., Chicago, Illinois, 1965.

3. Colliers Encyclopedia, Vol. 23. Crowell, Collier and MacMillan, Inc. 1966.

4. Oregon Outdoor Recreation, Parks & Recreation Division, Oregon State Highway Department, Salem, Oregon, June 1962.

5. List of Navigable Waters in Portland District, U. S. Army Engineer District, Portland, Oregon, June 30, 1965.

6. Oregon Fishing and Vacation Guide, 2nd Edition, H. B. Helstrom, Editor and Publisher, Portland, Oregon.

7. Oregon Boating Guide, Oregon State Highway Department, Salem, Oregon, 1966.

8. Dam pamphlets for Dorena (1965), Fern Ridge (1964), Lookout Point (1965), Detroit (1963), Cottage Grove (1963), Cougar (1965), Hills Creek (1964), and Green Peter and Foster (1964). U. S. Army Engineer District, Portland, Oregon.

9. Recreation and Wildlife Summary Reports, Calendar Year 1965, U. S. Bureau of Reclamation, Region I, Boise, Idaho.

10. Reservoirs in the United States, U.S.G.S. Publication No. 1360-A, U. S. Government Printing Office, Washington, D.C.

11. Areas of the United States, 1940, Prepared under the supervision of Clarence E. Batschelet, U. S. Department of Commerce, U. S. Government Printing Office, Washington, D.C., 1942.

12. Lengths of Shoreline in Washington State, Carlos B. Hagen, Published by Bureau of Surveys and Maps, Washington Department of Natural Resources, Olympia, Washington, 1958.

13. Atlas of the Pacific Northwest Resources and Development Second Edition, Edited by Richard M. Highsmith, Jr., Department of Natural Resources, published by Oregon State University, Corvallis, Oregon, 1957.

14. Lakes of Washington, Vol. I and II, by Ernest E. Wolcott, Washington Department of Conservation, Olympia, Washington, 1964.

15. Idaho Boating Laws-Regulations, Safe Boating Tips, 4th Edition, 1966. Published by Department of Law Enforcement, Boise, Idaho.

16. World Book, Vol. M. Field Enterprises Educational Corp., Chicago, Illinois, 1964.

17. "A Guide to Boating in Montana," Pamphlet by Montana Chamber of Commerce and Montana Fish and Game Commission, Helena, Montana.

18. Data compiled on navigable rivers. Federal Water Pollution Control Administration Laboratory, College, Alaska, 1966.

19. Report of Certificates of Number Issued to Motorboats, State of Oregon, State Marine Board, Salem, Oregon, December 31, 1966.

20. Report of Certificates of Number Issued to Motorboats, State of Idaho Department of Law Enforcement, Boise, Idaho, December 31, 1966.

21. Montana Boat Registrations, Montana State Board of Equalization, Helena, Montana, June 30, 1966.

22. Data of Recreational Boats in Washington, Washington Department of Commerce and Economic Development, Business and Economics Research Division, Olympia, Washington, June 1965.

23. Recreational Boating Statistics, U. S. Coast Guard Annual Reports for 1964 and 1965.

24. Pleasure Boating in Oregon, Oregon State Marine Board, Salem, Oregon, July 1966.

25. Personal Communication by Letter dated December 28, 1966, with R. F. Rittenhouse, Director, Oregon State Marine Board, Salem, Oregon.

26. Washington State Directory of Saltwater Boating Facilities, Tourist Promotion Division, Department of Commerce and Economic Development, Olympia, Washington, June 6, 1966.

27. Report of Washington State Parks and Recreation Commission, 1964-65, Annual Report, Olympia, Washington.

28. Design Memo #7B, Master Plan for Development and Management of Lower Monumental Reservoir, U. S. Army Engineer District, Walla Walla, Washington, 1966.

29. Preliminary Master Plans for John Day, 1966, Lower Granite, 1965, Lower Monumental, 1963, U. S. Army Engineer District, Walla Walla, Washington.

30. Dam Pamphlets for McNary (1966), John Day (1965), and Ice Harbor (1964-65), U. S. Army Engineer District, Walla Walla, Washington.

31. Dam Pamphlets for Bonneville and The Dalles, U. S. Army Engineer District, Portland, Oregon, 1965.

32. Design Memo #28A, Lower Granite Project, U. S. Army Engineer District, Walla Walla, Washington, 1965.

33. Recreation, U. S. Army Engineer District Civil Works Projects, Portland, Oregon, June 1965.

34. Boating and Cruising Guide Pacific Northwest, Standard Oil Co. of California, Rand McNally & Co., 1965.

35. Idaho Lakes and Reservoirs with Public Access and Use Areas, Information Bulletin No. 2, Idaho Fish and Game Department, Boise, Idaho.

36. Public Access Areas, Information Pamphlet No. 11, Idaho Fish and Game Department, Boise, Idaho.

37. Puget Sound Comprehensive Study, U. S. Army Engineer District, Seattle, Washington, June 1966.

38. Facts to Help You Know Washington, State Department of Commerce and Economic Development, Olympia, Washington, 1965.

39. Private Communication with Dr. Crutchfield, Economics Professor, University of Washington, Seattle, Washington, January 1967.

40. Letter from Washington State Department of Fisheries, January 12, 1967, Olympia, Washington.

41. Estimates of Catch, Effort, and Calculated Fishing Success, Oregon Offshore Sport Salmon Fishery, 1965, by Oregon State Game Commission and Statistics Department of Oregon State University, Corvallis, Oregon.

42. The 1965 Willamette River Spring Chinook Sport Fishery, Stout, W. H. and Collins, M.D., Oregon State Game Commission, Portland, Oregon, April 1966.

43. Waterborne Commerce of the United States, 1964, Part 4, Waterways and Harbors Pacific Coast, Alaska and Hawaii: U. S. Army Corps of Engineers, Government Printing Office, Washington, D.C.

44. Data from records on watercraft, Northwest Regional Office, Federal Water Pollution Control Administration, Department of the Interior, Portland, Oregon, January 1967.

45. Verbal communication on watercraft, Portland Office, U. S. Geological Survey, Department of the Interior, Portland, Oregon, January 20, 1967.

46. Data from records on watercraft, Bureau of Sport Fisheries and Wildlife, Department of the Interior, Boise, Idaho, January 1967.

47. Data from records on Watercraft, Regional Office, Bureau of Commercial Fisheries, Department of the Interior, Seattle, Washington, January 1967.

48. Data from records on watercraft, Boise District Office, Bureau of Land Management, Department of the Interior, Boise, Idaho, January 1967.

49. Data compiled on governmental watercraft, Federal Water Pollution Control Administration Laboratory, College, Alaska, February 1967.

50. Data from records on watercraft, U. S. Army Engineer District, Portland, Oregon, January 1967.

51. Data from records on watercraft, U. S. Army Engineer District, Walla Walla, Washington, January 1967.

52. Data from records on watercraft, U. S. Army Engineer District, Seattle, Washington, January 1967.

53. Data from records on watercraft, 13th U. S. Naval District, U. S. Navy, Seattle, Washington, January 1967.

54. Data from records on watercraft, District Office, U. S. Coast and Geodetic Survey, Department of Commerce, Seattle, Washington, January 1967.

55. Data from records on watercraft, U. S. Maritime Administration, Seattle, Washington, January 1967.

56. Data from two memoranda on waste water disposal practices by Maritime Administration, December 6, 1965, and December 7, 1965, Northwest Regional Office, Federal Water Pollution Control Administration, Department of the Interior, Portland, Oregon.

57. Data on boats from letter No. 2300, January 10, 1967, Pacific Northwest Region, U. S. Forest Service, Department of Agriculture, Portland, Oregon.

58. Data from records on watercraft, Intermountain Region, U. S. Forest Service, Department of Agriculture, Ogden, Utah, January 1967.

59. Data from letter No. 9360, January 12, 1967; records on watercraft, January 1967; telephone communication, February 2, 1967. 13th U. S. Coast Guard District, Treasury Department, Seattle, Washington.

60. Data from records on boats licensed at state level, Chief of Motor Vehicle Registration, Department of Law Enforcement, Boise, Idaho, January 1967.

61. Data from records on watercraft, Department of Game, State of Washington, Olympia, Washington, January 1967.

62. Data from records on watercraft, Parks and Recreation Department, State of Washington, Olympia, Washington, January 1967.

63. Data from letter on watercraft, Department of Fisheries, State of Washington, Olympia, Washington, January 12, 1967.

64. Data from records on watercraft, Washington State Ferries, Seattle, Washington, January 1967.

65. Data from Alaska Department of Fish & Game memorandum on watercraft, Vessel Supervisor, Division of Administration, Alaska Department of Fish & Game, Juneau, Alaska, November 14, 1966.

66. Pollutional Effects of Outboard Motor Exhaust-Laboratory Studies, JWPCF, English, J. N., McDermath, G. N., and Henderson, C., July 1963.

67. Pollutional Effects of Outboard Motor Exhaust-Field Studies, English, J.N., Surber, E.W., and McDermath, G.N., JWPCF, September 1963.

68. Evaluation of Marine Toilets Chlorinator Units, Research Report No. 9, 1962, New York State Department of Health.

69. Lease Agreement for Administration of Spangler Reservoir (Rough Draft), U. S. Department of the Interior, Bureau of Reclamation, Mann Creek Project, Idaho, November 1966.

70. Washington State Outdoor Recreation Guide, Washington State Parks and Recreation Commission, and Tourist Promotion Division, Department of Commerce and Economic Development, Olympia, Washington, June 1966.

71. Alaska Director of State Harbor Facilities, Department of Public Works Division of Water and Harbors, Juneau, Alaska.

72. Oregon Port Directory, The Port of Portland, Portland, Oregon, January 12, 1966.

73. 1966 Port Director, Washington Public Ports Association, Olympia, Washington.

74. Annual Reports (Statistics) and Waterborne Commerce of the United States, Part 4, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C., 1930-64.

75. Merchants Exchange Bulletin, Merchants Exchange, Portland, Oregon, December 1966.

76. 1965 Annual Report of Vessel Movements on Puget Sound, The Marine Exchange, Seattle Chamber of Commerce, Seattle, Washington.

77. The Port of Portland, Oregon, Port Series No. 34, Revised 1962, Part 2, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C.

78. The Ports of Coos Bay, Oregon; Longview and Vancouver, Washington, Port Series No. 33, 1963, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C.

79. The Ports of Everett, Bellingham, Port Angeles, and Anacortes, Washington, Port Series No. 37, 1963, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C.

80. The Ports of Tacoma, Grays Harbor, and Olympia, Washington, Port Series No. 35, 1963, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C.

81. The Port of Seattle, Washington, Port Series No. 36, 1963, U. S. Army Corps of Engineers, U. S. Government Printing Office, Washington, D.C.

82. Personel Communication by letter dated January 26, 1967, with C. A. Weberg, Assistant State Fisheries Director, Fish Commission of Oregon, Portland, Oregon.

83. 1965 Fisheries Statistical Report, State of Washington, Department of Fisheries, Olympia, Washington.

84. Private communication with the staff of Washington State Ferries, Seattle, Washington, January 1967.

85. Civil Engineering Department, Sanitary Engineering Division. University of Washington, Seattle, Washington, January 1967.

86. Data enclosed with letter No. 5700, February 8, 1967, 13th U. S. Coast Guard District, Treasury Department, Seattle, Washington.

87. U. S. Army Engineer District, Juneau, Alaska, January 1967.

88. Oil and Refuse Pollution, Navigable Waters of the United States, Alaska, U. S. Army Engineer District, Juneau, Alaska, 1965.

89. Northwest Regional Office, Federal Water Pollution Control Administration, Department of the Interior, Portland, Oregon.

90. U. S. Army Engineer District, Seattle, Washington, January 1967.

91. U. S. Army Engineer District, Portland, Oregon, January 1967.

92. Report of Study Pertaining to Marine Toilets and Chlorinators, Barber, Lawrence, Oregon State Marine Board, August 1962.

93. Chapter 488 of Oregon Revised Statutes, 1965 Replacement Part, Boats and Boating.

94. Report of the Pollution Study Committee National Association of State Boating Law Administration, Warwick Hotel, Philadelphia, Pennsylvania, November 8, 1965.

GENERAL REFERENCES

1. Report on Portland Harbor Development Survey, Commission of Public Docks, Portland, Oregon, 1959.

2. Policy Governing the Water Pollution and Public Health Aspects of Outdoor Recreation, Recreation Advisory Council, Washington, D.C., Circular No. 3, April 9, 1964.

3. Rules and Regulations Regarding Permits for the Discharge of Wastes from Commercial and Industrial Operations into State Waters," Washington Pollution Control Commission, Olympia, Washington, Adopted July 21, 1955.

4. Rules and Regulations for the Submission and Approval of Plans for the Installation of Public Sewage and Industrial Waste Works and for the Operation of Such Works, State of Washington Pollution Control Commission and Department of Health, Olympia, Washington, 1966.

5. Regulations Regarding the Discharge of Waste Products to the Canals, Drains, Wasteways, Reservoirs, and Ground Waters of the Columbia Basin Irrigation Project Area and Minimum Standards for the Treatment and Disposal of Sewage and Industrial Wastes in the Area, State of Washington Pollution Control Commission, Olympia, Washington, March 1954.

6. Idaho Motor Vehicle Laws, Department of Law Enforcement, Boise, Idaho, 1965.

7. A Uniform Method for Measuring and Reporting Recreation Use on the Public Lands and Waters of the United States, Recreation Advisory Council, Study Committee Number Two, Washington, D.C., April 1965.

8. Survey of Marina and Watercraft Use in Relation to the Public Health Aspects, Macomb County Health Department, Mt. Clemens, Michigan, 1963.

EXHIBITS

Bibliography Numbers

EXTENT OF WATERWAYS

1. Navigable Coastal and Inland Waterways, Pacific Northwest — 5
2. Lakes and Reservoirs Greater than Ten Square Miles, State of Idaho — 15

RECREATIONAL WATERCRAFT AND SUPPORTING SHORE FACILITIES

3. Recreational Watercraft in the Pacific Northwest, (excluding Alaska) — 19-22
4. Supporting Shore Facilities for Pleasure Craft, State of Oregon — 4,6-9,28-34
5. Supporting Shore Facilities for Pleasure Craft, State of Washington — 26,70
6. Supporting Shore Facilities for Pleasure Craft, State of Montana — 17
7. Directory of State Harbor Facilities, State of Alaska — 71

COMMERCE, COMMERCIAL WATERCRAFT AND SUPPORTING SHORE FACILITIES

8. Port Directory, States of Oregon and Washington — 72,73
9. Traffic through Bonneville, Dalles, and Willamette Falls Locks, 1930-1965 — 74
10. Commercial Shipping for Washington Ports, 1964 — 43
11. Commodities Shipped In and Out of Portland and Seattle Harbors, 1964 — 43

		Bibliography Numbers
12.	Commercial Water Traffic, Columbia and Snake Rivers, 1964	43
13.	Commercial Water Traffic, Oregon, 1964	43
14.	Commercial Water Traffic, Washington, 1964	43
15.	Commercial Water Traffic, Idaho, 1964	43
16.	Traffic Statistics for State Ferries, State of Washington, 1956-1965	64
17.	Commercial Water Traffic, Alaska, 1964	43
18.	Number and Registry of Commercial Vessels Arriving in Portland, 1965, 1966, and Puget Sound, 1965	75,76
19.	Piers, Wharves, and Docks, Port of Portland, Oregon, 1962	77
20.	Piers, Wharves, and Docks, Port of Coos Bay, Oregon, 1963	78
21.	Piers, Wharves, and Docks, Port of Anacortes, Washington, 1963	79
22.	Piers, Wharves, and Docks, Port of Bellingham, Washington, 1963	79
23.	Piers, Wharves, and Docks, Port of Everett, Washington, 1963	79
24.	Piers, Wharves, and Docks, Port of Grays Harbor, Washington, 1963	80
25.	Piers, Wharves, and Docks, Port of Longview, Washington, 1963	78
26.	Piers, Wharves, and Docks, Port of Olympia, Washington, 1963	80
27.	Piers, Wharves, and Docks, Port of Port Angeles, Washington, 1963	79
28.	Piers, Wharves, and Docks, Port of Tacoma, Washington, 1963	80

		Bibliography Numbers
29.	Piers, Wharves, and Docks, Port of Seattle, Washington, 1963	81
30.	Piers, Wharves, and Docks, Port of Vancouver, Washington, 1963	78
31.	Commercial Fisheries, State of Oregon	82
32.	Commercial Fisheries, State of Washington	83
33.	Commercial Fishing Fleet, State of Washington, 1959	40

GOVERNMENTAL WATERCRAFT
AND
SUPPORTING SHORE FACILITIES

34.	Federal Watercraft, Pacific Northwest, 1966	44-59
35.	State Watercraft, Pacific Northwest, (excluding Oregon), 1966	60-65
36.	Supporting Shore Facilities, Washington State Ferries, State of Washington	84

WATERCRAFT POLLUTION

37.	Letter dated December 23, 1966, State of Montana, State Board of Health	
38.	Letter dated January 6, 1967, Marion County Sheriff's Office, Salem, Oregon	
39.	(Proposed Study) Bacteriological and Esthetic Effects of Pleasure Boat Waste Discharge on Small Harbors, University of Washington, Seattle, Washington	85
40.	Oil Pollution Investigation, Navigable Waters of the Pacific Northwest, (excluding Alaska), January 1965 - December 1966	86
41.	Oil Pollution Investigation, Navigable Waters of the Pacific Northwest, (Alaska), July 1956 - January 1967	87

		Bibliography Numbers
42.	Oil and Refuse Pollution Report, State of Alaska	88
43.	Special Report, Loss of Marine Life on Pacific Beaches of Quinault Indian Reservation and Adjoining Areas, Washington - Incidental to Stranding of Petroleum Barge at Moclips, Washington, March 11 to 17, 1964	
44.	Engineering Report on the Butterworthing of the HAWAIIAN RANGER at Terminal 4, June 15, 1966	82
45.	Letter dated July 26, 1966, State of Alaska, Department of Health and Welfare	
46.	Interoffice memorandum, Federal Water Pollution Control Administration, Department of the Interior, June 30, 1966	89
47.	Spoil Areas on Navigable Projects, U. S. Army Engineer District, Portland, Oregon	50
48.	Dredging Schedule, U. S. Army Engineer District, Seattle, Washington	90
49.	Letter from Oregon State Sanitary Authority, January 27, 1967, regarding Watercraft Pollution	
50.	Department of the Army, Office of the Chief of Engineers, Washington, D. C., Regulation No. 1125-2-302, Plant, Sewage Disposal Equipment, October 28, 1965	91
51.	Report and Addendum to Report of Study pertaining to Marine Toilets and Chlorinators, , August 1962	92
52.	Letter from Naval Facilities Engineering Command, Department of the Navy, May 16, 1966, regarding Sewage Collection System	53
53.	Waste Water Disposal Practices of the U. S. Maritime Administration, December 6, 1965	89

Bibliography Numbers

LEGISLATION AND REGULATIONS

54. Portland, Oregon, City Ordinances, Section 16

55. Seattle, Washington, Ordinance No. 73578, October 23, 1944

56. Seattle, Washington, Building Code, Chapter 3.74, Ordinance No. 82223, October 21, 1964

57. Water Pollution Control Regulations, Idaho State Board of Health, May 11, 1959

58. State of Washington, Pollution Control Commission, Chapter 216, Laws of 1945 and Chapter 71, Laws of 1955

59. Alaska Statutes, Water Control Act

60. House Bill No. 53, State of Montana

61. Chapter 362, Senate Bill 185, 1965 Oregon Laws

62. State Marine Board Regulations, State of Oregon 93

63. Boat Operations in Deschutes County, Oregon, Oregon State Marine Board

64. U. S. National Park Service, Code of Federal Regulations

65. U. S. Forest Service Regulation regarding Diamond Lake, July 16, 1962

66. U. S. Army, Corps of Engineers, Code of Federal Regulations

67. U. S. River and Harbor Act of March 3, 1899, 33 U. S. Code 407

68. U. S. Oil Pollution Act of 1924, 33 U. S. Code 431-437

69. SOPA Puget Sound Instruction P3400.1A

70. Canada Shipping Act, Oil Pollution Prevention Regulations

71. Model Act on Sewage Disposal from Boats

Bibliography Numbers

72. A model Act to Prohibit Littering and the Disposal of Untreated Sewage from Boats 94

73. Litter and Pollution Panel, Interclub Association of Washington, November 1966

74. Proposed Policy on Sewage and Waste Disposal from Vessels, Division of Environmental Engineering and Food Protection, U. S. P. H. S.